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Population Abundance of Insect Trapped on Different Colours of Sticky Trap in Pumpkin (*Cucurbita moschata*) Field

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ABSTRACT

A study was conducted to attract insects using different colours of sticky trap in pumpkin (*Cucurbita moschata*) field. Sticky trap was chosen as it is one of a method to estimate the insect population density in field as it requires a low cost and less skilled labour. Four different colours of sticky traps (i.e. red, white, blue and yellow) were used to determine the insect population abundance at the pumpkin field. All the traps were installed at the height of 100 cm at a random of 1 ha of pumpkin plot with five replicates for each colour and the insect samples were collected weekly for three months (October-December 2019). Overall, a total of 13,052 insects were collected throughout 11 weeks of sampling. The results showed that the percentage of insect population abundance recorded the highest was on week eight (15.01%) whilst the least abundance of insects trapped was on week one (2.28%). The most attractive colour to attract insects was significantly the yellow colour (44.34%) followed by blue (20.12%) and white (19.15%) whilst the lowest insect trapped was on red colour (16.40%). A total of nine insect orders recorded were; Diptera, Hemiptera, Coleoptera, Hymenoptera, Lepidoptera, Orthoptera, Blattodea, Isoptera and others. Diptera was the most abundant of insect's order trapped in the yellow trap with 3427 individuals and followed by Hemiptera order (1022 individuals). Whilst the Isoptera order was the least number of insects caught on a red colour trap with only one individual. In conclusion, our findings showed that the yellow sticky trap colour is the most attractive to attract insects of *C. moschata* compared to other colours. Therefore, this study could provide essential knowledge that may be useful for the future ecological survey of insects of *C. moschata*.

Keywords: *Cucurbita moschata*, insect, population abundance, sticky traps

INTRODUCTION

Pumpkin or *Cucurbita moschata* (Duch.ex Lam) is a Cucurbitae genus gourd-like squash and belongs to the Cucurbitaceae family. It was significantly different in each genotype and the first flowering range was 52 to 73 days and days to maturity ranged from 104 to 123 days (Ahamed et al., 2012). It is a trendy vegetable in many tropical and subtropical countries, such as Malaysia, which produces its pumpkin, with substantially large production areas compared to its high global demand (Kamarubahrin et al., 2018).

Pumpkin crop is vulnerable to various insects including the pests and diseases. Cucurbitaceous crop such as pumpkin is commonly attacked by thrips, fruit flies, caterpillars, moths, and beetles which occur in various parts and stages of plant development, particularly in leaves, branches and fruits (Lima & Filho, 2018). Deyto and Cervancia (2009) listed that Hymenopteran (*Apis dorsata, A. mellifera, Trigona* spp., *Halictus* spp*., Xylocopa* spp. and Formicidae), Lepidopteran, Coleopteran (Chrysomelidae) and Dipteran (*Calliphora* spp., Sarcophagidae, and Syrphidae) commonly visit *C. moshata.* Among them, the red pumpkin beetle, *Aulacophora foveicollis* Lucas *(*Chrysomelidae*)* is the major pest of *C. moshata* which the adult feed voraciously on leaves, flower buds and flowers which the losses of this pest have been reported to 30-100% in the field (Muhammad Aamir Rashid et al., 2014).

Thus, the farmers had to use an extensively different type of insecticide to control the insect's problem at fields (Shrestha et al., 2019). However, the excessive use of different insecticides for controlling the insect's pest by the farmer lead to the safety issues and indirectly lead to undesirable insect resistance problems (Soniya Devi et al., 2017). Therefore, the use of sticky trap as the mechanical control method in Integrated Pest Management (IPM) by determining the colour preference of crop which may help develop insect traps using such attractive colours. Thus, it will providing opportunities for pest control in integrating specific colours into crop management methods (Soniya Devi et al., 2017). In addition, this method will assist the farmers to monitor the insect population in their field especially the pests as it helps determine if the threshold has been reached and whether control measures have been effective.

As the coloured sticky traps are straightforward and low-cost method for determining the insect population's in field, therefore, this study aimed to determine the population abundance of insects that attracted to the different colour of sticky traps in *C. moschata* field.

MATERIALS AND METHODS

Experimental site and time of sampling

The study was conducted at the 1 ha of *C. moschata* field of the Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin (UniSZA), Besut Campus, Besut, Terengganu (5.754942 N, 102.630745 E). The insect sampling starts in the early of October, which on 1st October 2019 until 10th December 2019 (11 weeks).

Sampling method

The method was adopted and modified based on Dreistadt et al. (1998) and Yaniv et al. (1999). The pumpkin seedlings (variety of *C. moschata*) were grown in the greenhouse, and the next 14 days, the seedling were transplanted on 21st September 2019 into raised flatbeds with 50 cm distance between plants and 3 m between accessions. No chemical pesticide and herbicide products were used during the study period and only organic fertilizer was applied to the plant every month.

Sticky trap card (15 cm x 20 cm) for each colour were produced by colour lamination of the different colour papers, secured to the 100 cm long wooden logs. A transparent plastic was covered for each card. Then, all the cards were uniformly sprayed with Anti-Pest Sticky Spray (CHEMI-BOND) on the surface of each plastic cover. The sticky trap cards were then set up in the center of the experimental site (210 ft x 420 ft) which the traps were placed between the 12 rows of the seedbed. Each row of *C. moschata* flatbeds consisted 50 *C. moshata* plants and one of the four sticky trap colours (i.e. white, red, yellow, and blue) was placed in the each plants row with 1 m distance between each trap card colour. A new sticky plastic cover on each card was replaced at weekly intervals. Insects that trapped on the plastic cover were brought to the laboratory for further identification process. The sampling was done with five replications for each four colours of the cards therefore a total of 20 cards were placed in 1 ha of the pumpkin field.

Insect identification

Insect identification process was done in the Laboratory of Entomology, Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin (UniSZA), Besut Campus. Insects that trapped on the plastic cover were removed by soaking for 10 to 15 minutes in cooking oil as mentioned by Petzold-Maxwell (2011). Oil treatment can eliminate the adhesive on the insects. Then, the samples were washed with 70% of ethyl alcohol into Petri dishes and kept until the specimens were entirely clear. The identification of insect orders was based on their morphological and physical characteristic under stereoscopy microscope (Olympus SZ51, Japan). All the specimens were identified based on Triplehorn and Johnson (2005).

Data analysis

The One-way Variance Analysis (ANOVA) was used to measure the population abundance of insect and the insect orders on different sticky trap colours as well as the weekly intervals. Two-way ANOVA analysis of variance was used to estimate the abundance of insects caught on the sticky traps based on the insect orders and the different colours of sticky trap. The data were pooled over the weeks of sampling due to the low number of insects representing each order on the trap's colours during certain weeks of sampling. Comparisons of mean and standard deviation numbers obtained in trap samplings were made using the least significant differences (LSD) test. All ANOVAs analysis was done at a significance level of $P<0.05$ by the use of IBM SPSS statistics software (SPSS, 2006).

RESULTS AND DISCUSSION

Determination of insect population abundance based on week interval

The insect population abundance based on week interval was shown in Fig. 1. Overall, a total of 13,052 insects were collected throughout 11 weeks of sampling. Result showed that there was a significant difference ($p<0.05$) of the mean of the insect population abundance during 11 weeks of sampling (Fig. 1).

Based on Fig. 1, the percentage of insect population abundance on week seven (14.97%), eight (15.01%) and eleven (11.51%) were not significantly different ($p>0.05$) but they were significantly higher compared to other weeks. Meanwhile, the number of insects trapped were recorded significantly the lowest on week one (2.28%) and followed by week four (5.45%). But no significant different ($p>0.05$) of insect abundance between week two (6.62%), three (6.53%), four (5.45%), five (6.64%), six (9.97%) and nine (8.60%). The variation of insect's numbers at different weeks of sampling indicating that *C. moschata's* vegetative stage may influences the number of insects that attract to each of the crop stages (Nsubuga, et al., 2020). Most probably, the highest number of insects recorded in week seven and eight was that the female flowers of *C. moschata* begin to appear after week seven to eight and once pollinated, the pumpkins would start to grow about seven days after the female flowers emerge (Nsubuga et al., 2020). Moreover, the flower colour of *C. moshata* is also bright yellow therefore it might be attracted more insects to the field during the flowering season (i.e week 7 and week 8). Therefore, at this stage many pollinators insects such as bees and some flies and also pests were attracted to the crop. For example, Marina et al. (2018) reported that at the pre-flowering stage about 360 individuals of insects were caught on cucumber *Cucumis sativu*s crops, while 1682 individuals caught from insect pests during the fruiting period; hence, about 95 percent or more of Cucurbits insect injury is likely caused by feeding the crops in various ways (Robert, 2019). However, the insects decreased significantly on week 9 which this might be due to a rainy season during this period as Shipman (2011) indicated that insect visitation on crops had been affected by changing weather conditions.

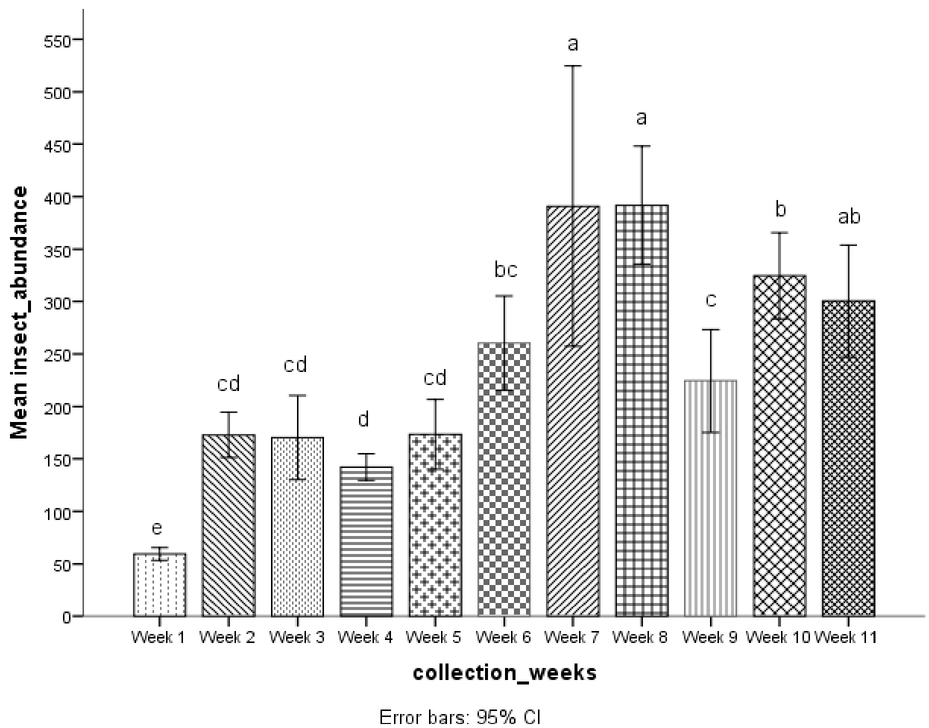

Fig. 1. The mean of insect abundance per weeks of insect sampling. Different letters represent the significance at the 5% level of LSD test.

Determination of insect population abundance on different colour of sticky traps

Fig. 2 shows the population abundance of insect on different colour of sticky traps. It was noted that the most abundant insects trapped was significantly on the yellow sticky trap (44.34%) followed by a blue sticky trap (20.12%), and white sticky trap (19.15%) whilst the least significant of insect abundance trapped was on the red sticky trap (16.40%). However, no significant different ($P>0.05$) of insects numbers were recorded between blue, white and red sticky trap colours (Fig. 2).

Based on Fig. 2, the yellow colour sticky trap caught significantly the highest number of insects. This might be due to its bright colour that attracted all the orders of the insects. Dreistadt et al. (1998) stated that bright yellow (about 550 to 660 nm wavelength) is highly attractive to any insect while Shipman (2011) mentioned that in a higher average percentage of individuals, insects found more on yellow flowers although there was no difference between the colours of red and white flowers. Nonetheless, it was noted that the blue sticky trap was also attractive to insects but only to some type of insect species. Generally, the blue responses are highly sensitive, with a noticeable decrease in red, although there are exceptions (Hering, 2012). For example, thrips insect attracted by the blue colours of sticky traps which can be proven on the use of blue traps colour on violets in Africa especially vulnerable to thrips infestation (Dreistadt at al., 1998). Whilst the red colour of sticky traps showed the least attractive to insects. Abu-Ragheef et al. (2020) showed that there is no significant impact of red colours on the number of insects due to the low number of insects trapped, so they suggested that the growers should avoid using red-coloured traps to monitor the insect's population.

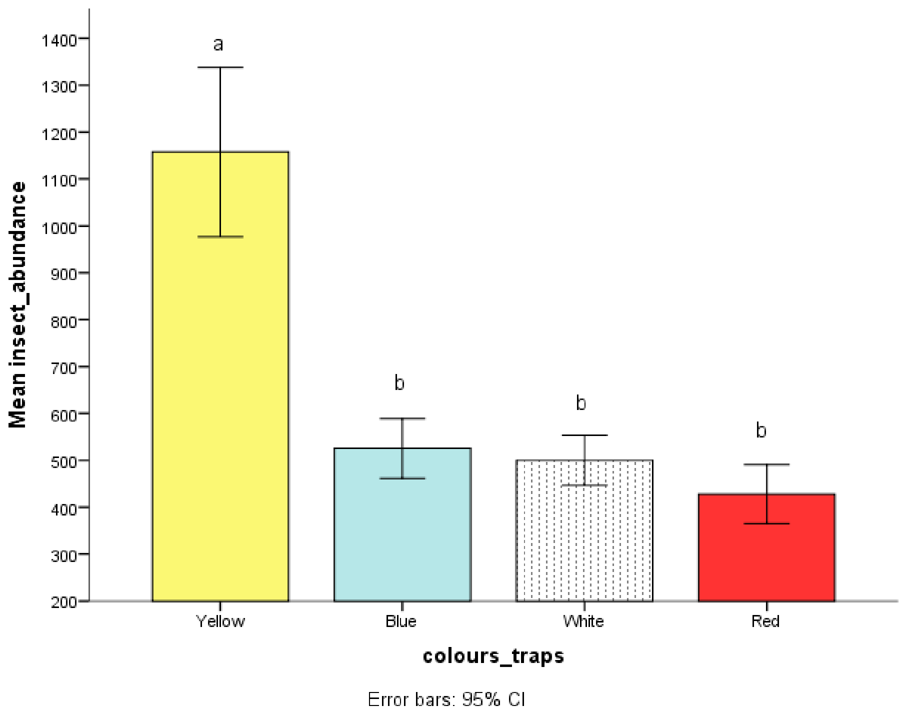

Fig. 2. Insect abundance per different colours of sticky traps. Different letters represent the significance at the 5% level of LSD test.

Determination of insect orders trapped on different colours of sticky traps.

Fig. 3 displayed a total of insect orders successfully collected in four different colour of sticky traps. Result shows that there were nine insect orders recorded which were Diptera, Hemiptera, Coleoptera, Hymenoptera, Lepidoptera, Orthoptera, Blattodea, Isoptera, and others. A significant difference ($p<0.05$) was recorded between the insect's orders, which Diptera was the highest order recorded in the yellow sticky trap followed with Hemiptera and Coleoptera, whilst Hymenoptera was slightly lower compared with Hemiptera and Coleoptera. The other four orders displayed about almost the same number of individuals except for the other insects, Lepidoptera, Orthoptera, Blattodea, and Isoptera. Similarly, Fayyaz et al. (2016) recorded nine orders of insects collected from pumpkin plantation in Pakistan which were Coleoptera, Lepidoptera, Hymenoptera, Homoptera, Thysanoptera, Hemiptera, Dermaptera, Diptera and Orthoptera.

This result revealed that out of the nine orders, dipteran was captured more frequently, indicating that it was the most abundance insects in the experimental field on yellow sticky traps followed by blue and white, whilst the red sticky trap was the least number of dipteran captured. Meanwhile the hemipteran, coleopteran, and hymenopteran significantly less caught in this type of sticky traps colours.

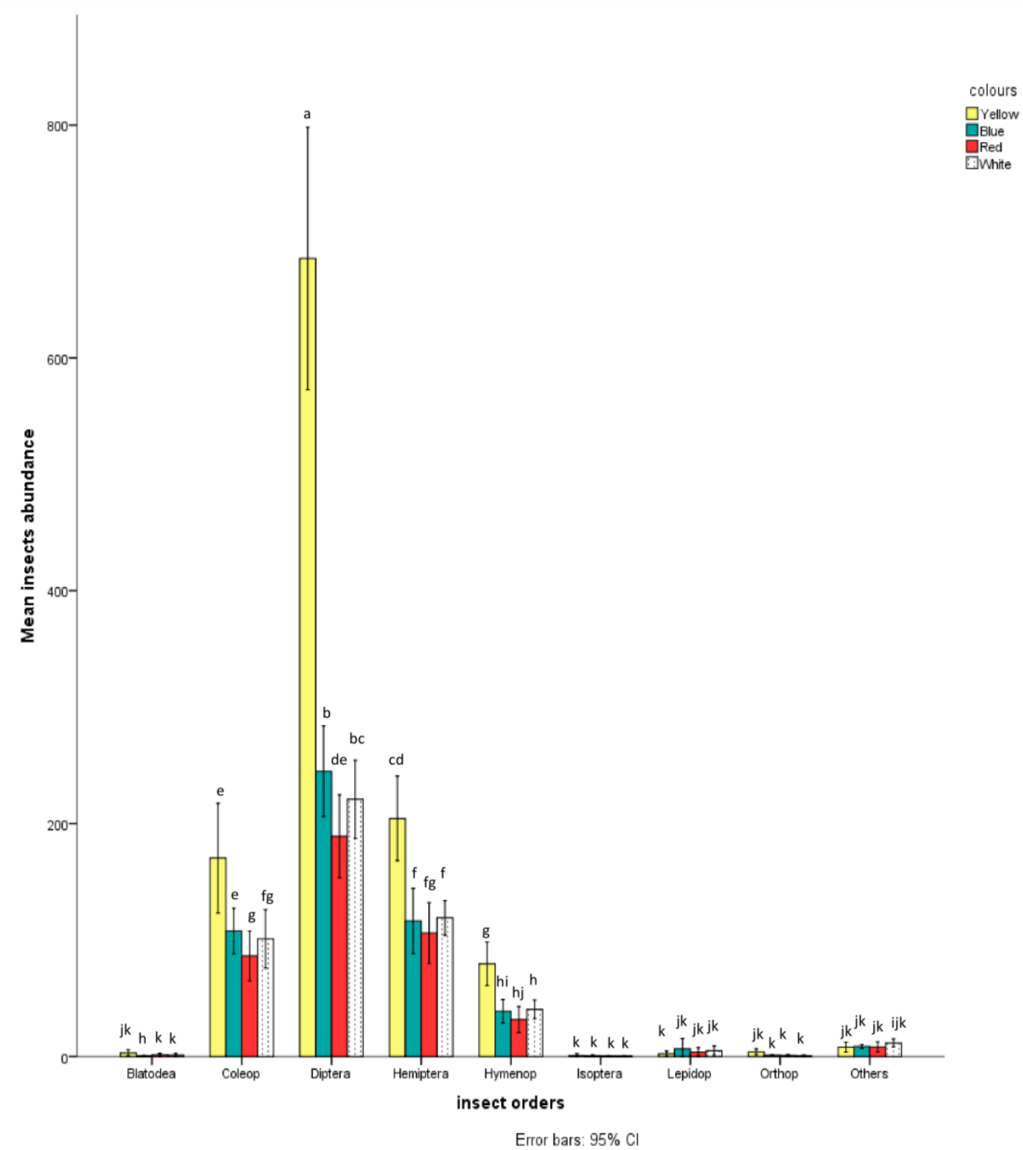

Fig. 3. Insect abundance per different of insect's order and different colours of sticky traps. Different letters represent the significance at the 5% level of LSD test.

In the meantime, most of the insect orders (i.e., Lepidoptera, Orthoptera, Isoptera, Blattodea, and others) were the least set of insects attached to the sticky traps. The Lepidoptera shows a preference for the colour of sticky traps as well as some spiders (Araneae), Orthopterans, Isopteran, and Blattodea were also collected on the sticky traps but relatively in a very small numbers. These orders may have been an incidental by-catch, particularly Orthoptera, Blattodea, and Isoptera, which can jump or fly onto the sticky traps by the wind as these three orders were caught only once in a while. Also, Araneae, Orthoptera, and Blattodea may participate in or affected by the Cucurbitaceae pollination networks.

Zakka et al. (2016) reported that 12 insect species belonging to eight families in three orders collected at *Cucurbita maxima* at different stages of crop development. Other than that, three beneficial species of Apidae, Coccinellidae, and Braconidae have been collected, respectively, as pollinators, predators, and parasitoids. Some insects, such as a cucurbit fruit fly, *Bactrocera cucurbitae* (Coquillett) that cause a problem in the field, also has been recorded (Sohrab et al., 2018). This might be an explaination of the abundance of dipteran mostly trapped on the sticky traps in all four colours. Moreover, Pobozniak et al. (2019) stated that the mean number of predatory *Aeolothrips intermedius* caught in the yellow traps was higher in both years than in the blue and white traps, suggesting that yellow was the most desirable colour followed by blue and white. Thus, the insects are attracted to that shade of yellow because it closely resembles pollen. Nonetheless, the highest catch of coccinellid pests, honey bee, hoverfly, and parasite wasp recorded in a yellow sticky trap.

On the other hand, the blue colour trap attracts honey bee, hoverfly, and parasite wasp (Soniya Devi et al., 2017). The blue colour was selected because blue usually used to monitor Thysanoptera and yellow traps in agricultural environments to track pests such as Homoptera and Diptera. Those observed by Hoback et al. (1999) and collected with Poduridae more frequently on yellow traps, and more regularly, Dolichopodidae and Thripidae collected in blue colour traps.

For the other colour of traps, Hoback et al. (1999) found that the tephritid flies are drawn to yellow during oviposition before maturation and red. Although Campbell et al. (2017) observed that red traps were almost entirely ineffective for Hymenoptera, but most Hymenoptera treated the colour red as black or dark as "red blind." Though Atakan and Pehlivan (2015) recorded that Lepidopteran (*Apis mellifera*) on white traps that were significantly higher individual numbers than yellow and blue traps but on Cucurbit crops, the Lepidopteran was more attracted to blue colour traps than other colours.

CONCLUSION

Based on the results, it can conclude that sticky trap was an alternative tool for monitoring insects, which is cheaper and almost equally useful for small insects, especially for *C. moschata* crops. The current study shows that insects mostly abundance on weeks seven and eight, which at this time, the *C. moschata* crops was starting to bloom as well as to form fruits, and also during this time, the grower need careful supervision to prevent crops injury. Additionally, yellow sticky trap was found to capture the most insect's population on the *C. moschata*. The results showed that nine orders of insects were recorded in which the most dominant order was Diptera, Hemiptera, Coleoptera, and Hymenoptera. In the future, it is a vital knowledge according to colour attractiveness on different insects' order which may help farmers to arrange the selection of trap colour, also the right timing of trap placement in the crop field.

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